

# Ocean Literacy- Research Connections

***Essential Principle:  
The ocean is a major influence on weather and climate***

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# Ocean Literacy- Research Connections

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- **A major area of research is studying the linkages between the oceans and climate. Some recent publications:**
  - *Global Warming Will Alter Character of the Northeast (NECIA)*
  - *Climate Impacts of the Atlantic Multidecadal Oscillation (Geophysical Research Letters, 02-Sep-2006)*
  - *Trajectory Shifts in the Arctic and Subarctic Freshwater Cycle (Science, 25-Aug-2006)*
  - *Atlantic Hurricane Trends Linked to Climate Change (EOS-Newsletter of the American Geophysical Union, 13-Jun-2006)*
  - *Snowy Northeast Can Thank La Niña (Discovery News, 14-Feb-2006)*

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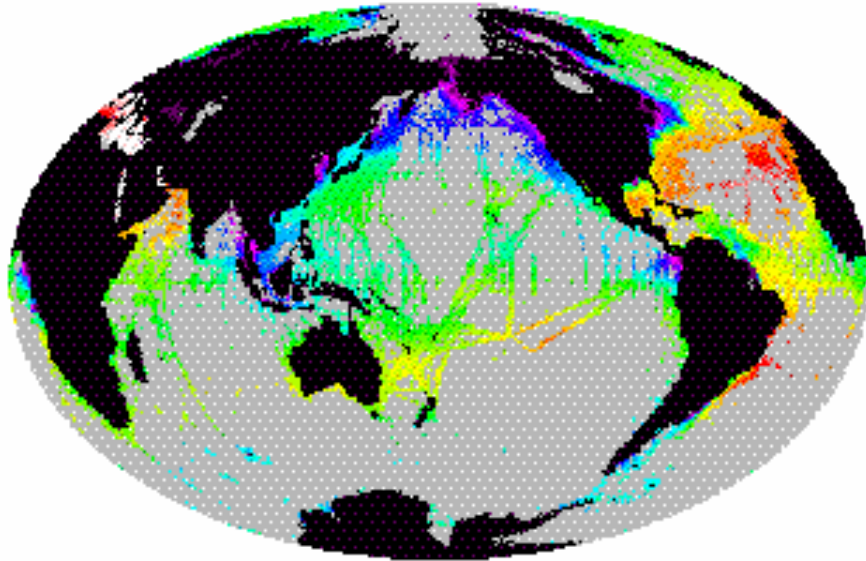
- **Salinity is a major component of ocean-climate research.**  
**Some recent publications:**
  - *Researchers Link Ice Age Climate-change Records to Ocean Salinity (Nature, 05-Oct-2006)*
  - *Rapid Subtropical North Atlantic Salinity Oscillations Across Dansgaard-Oeschger Cycles (Nature, 05-Oct-2006)*
  - *Climate Change: A Sea Change (Nature, 19-Jan-2006)*
  - *Arctic Ocean Change Heralds North Atlantic Freshening (Geophysical Research Letters, Nov-2005)*
  - *Influence of the Atlantic Subpolar Gyre on Thermohaline Circulation (16-Sep-2005)*

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*Sea Surface Salinity (SSS)*

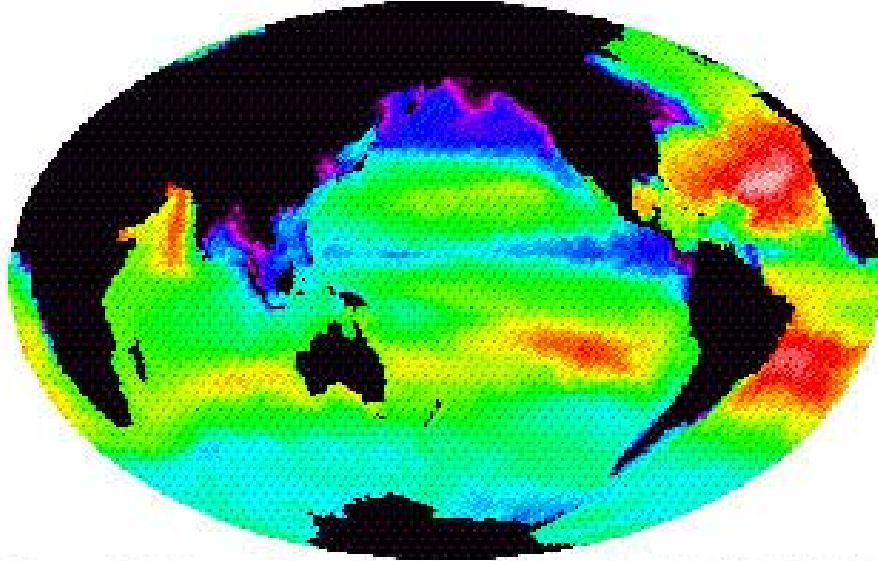
This map shows all known measurement locations sampled over the past 100 years for Sea Surface Salinity (SSS).

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*Example 7 days of Aquarius Sea Surface Salinity (SSS) data*

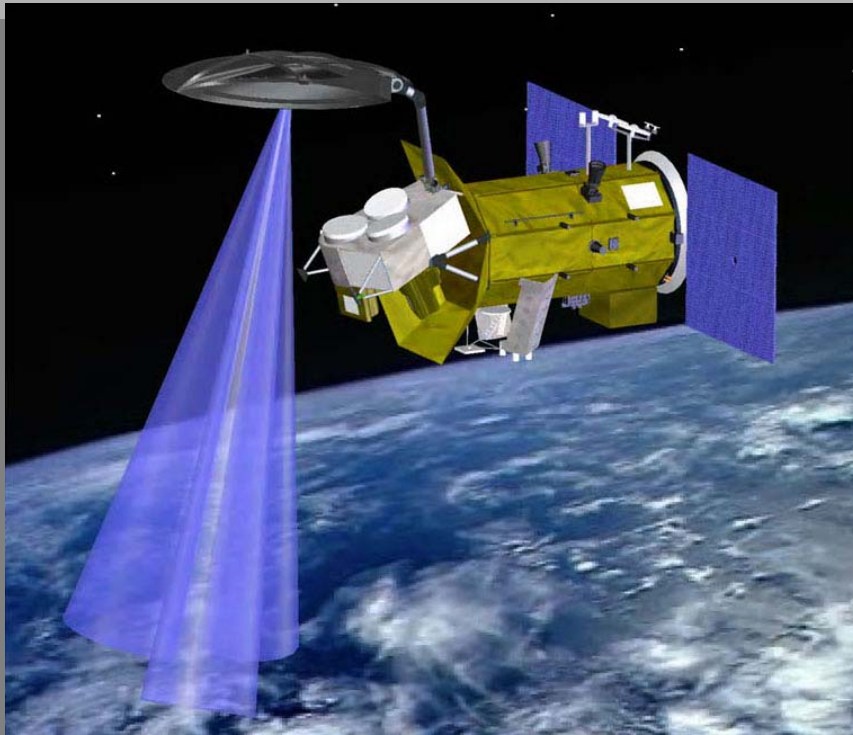
Not presently measured by satellite, this map shows the weekly SSS coverage that will be achieved by *Aquarius* after its July 2009 launch.

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**Aquarius instrument accuracy will be 0.2 psu\*. How much salt should be added to 1 gallon of water to change its salinity by 0.2 psu?**

- 1 tablespoon
- 1 teaspoon
- **1/6 teaspoon**
- 1/10 teaspoon

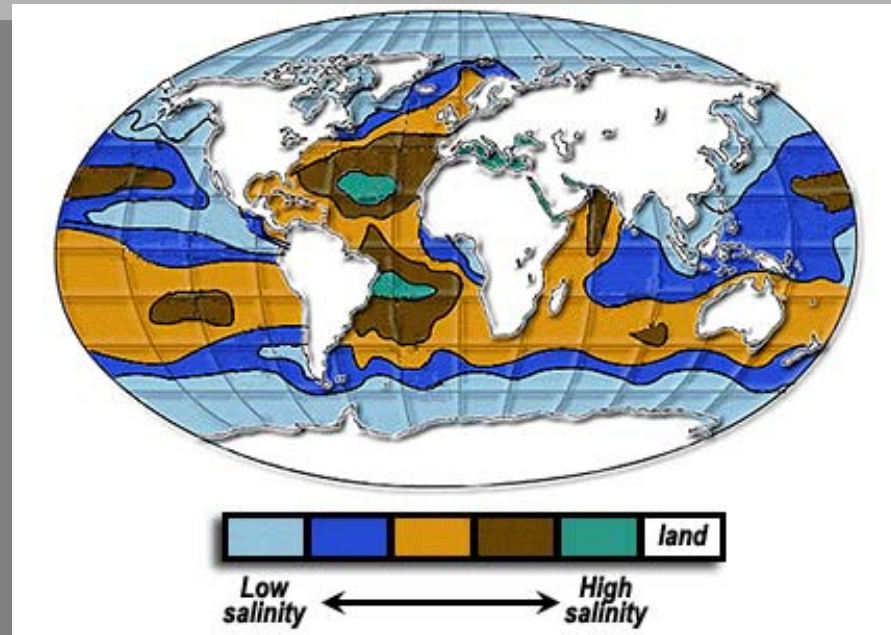
*\*Used to describe the concentration of dissolved salts in water, the UNESCO Practical Salinity Scale of 1978 defines salinity in terms of a conductivity ratio, so it is dimensionless. Salinity was formerly expressed in terms of parts per thousand or by weight (parts per thousand or 0/00). That is, a salinity of 35 ppt meant 35 pounds of salt per 1,000 pounds of seawater. Open ocean salinities are generally in the range between 32 and 37.*

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The mission will help answer questions about how our oceans respond to climate change and the water cycle.

Like on land, some areas of the ocean are rainy whereas others are arid. *Aquarius* SSS data will reveal the water cycle's ever-changing "fingerprint."

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Isabel develops in the North Atlantic



Red areas show areas of heavy rainfall



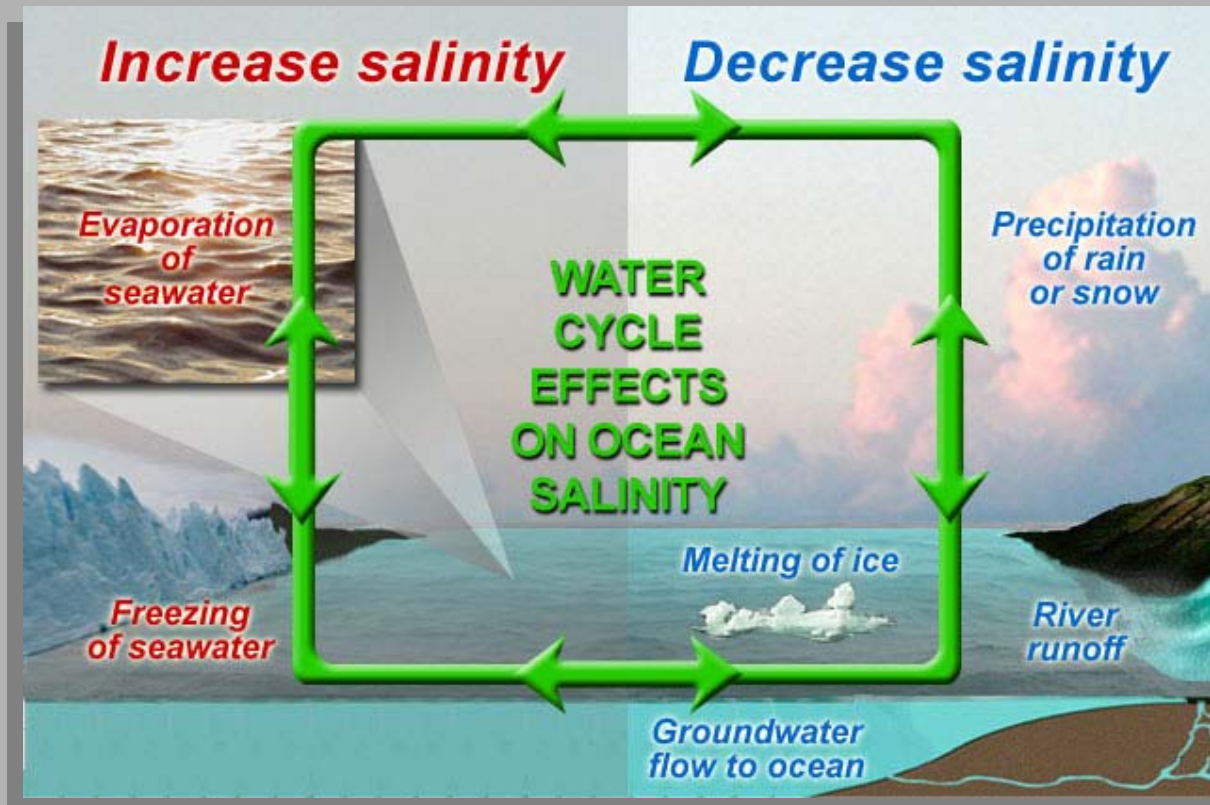
Isabel hits the U.S. southeastern coast

*Hurricane Isabel (2003) accumulation of rainfall as measured by the NASA TRMM satellite. Over 400 trillion tons of freshwater were dumped on the North Atlantic Ocean during this event.*

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SSS maps can be used to directly track variations in the water cycle such as river runoff, sea ice freezing & melting, ocean evaporation & precipitation:




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## The ocean is a major influence on weather and climate

Our education deliverables – "Salinity Patterns & the Water Cycle" – are activities designed to meet physical science content standards for grades K - 12.

<http://aquarius.nasa.gov/education.php>



**AQUARIUS**  
Education & Public Outreach

HOME | OVERVIEW | SCIENCE | TECHNOLOGY & OPERATIONS | GALLERY | EDUCATION | NEWSROOM | LINKS | SITE MAP

**EDUCATION: Classroom Activities**

A goal of Aquarius is demonstrating how improved understanding of salinity-driven circulation – and its influence on *climate* and the water cycle – can benefit student learning. Sea surface *salinity* is key to learning about the water cycle because 86% of global *evaporation* and 78% of global *precipitation* occur over the oceans. Our "Salinity Patterns & the Water Cycle" resources are aligned with the National Science Education Standards for Physical Science (grades K - 12). They include "hands on" laboratory exercises (e.g., density, evaporation, freezing, melting, salt-water chemistry):

- Potato Float** Understand how the same object can both sink and float, depending on its density relative to a fluid
- Liquid Rainbow** Use analytical thinking by devising schemes to stack five solutions of different densities
- You Can Dew It!** Learn about the relationship between temperature and condensation
- Salt Water Painting** Observe and understand the process of evaporation
- Sea Water Freeze** Freeze liquids of varying salinity & learn how it relates to the buoyancy of sea ice and icebergs
- Measuring the Density of Water** Discover that whether an object will float depends on the amount / density of water that it displaces
- Properties of Fresh & Sea Water** Conduct experiments on the boiling point, freezing point, and heat capacity of fresh water and sea water
- Sea Water Mixing & Sinking** Use temperature-salinity (T-S) diagrams to understand the importance of seawater density studies
- Super Cool** See salt-ice relationships through experimentation
- Electrolysis of Salt Water** Conduct an experiment to see that water can be split into its constituent ions through the process of electrolysis
- The Nature of Salt** Students research the structure of salt to understand the difference between molecular compounds and ionic compounds

Questions or comments? Contact [Annette deCharon](#), Senior Science Educator and Aquarius EPO Manager

HOME | LINKS | NEWSROOM | SITE MAP  
OVERVIEW | SCIENCE | TECHNOLOGY & OPERATIONS | GALLERY | EDUCATION

**EDUCATION**  
**SALINITY BASICS**  
**CLASSROOM ACTIVITIES**  
**SALINITY DATA & TOOLS**  
**LINKS**

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"Can Sea Water Freeze?" is a middle school classroom activity.

After making ice from fresh and salt water, students learn the differences between sea ice and ice bergs.

FREEZER EXPERIMENT							
Record your observations below:							
Jar	Starting salt / water content	1 hour in freezer		24 hours in freezer		48 hours in freezer	
		Temp	Notes	Temp	Notes	Temp	Notes
A							
B							
C							
D							

BUOYANCY EXPERIMENT				
	Ice from "A"	Ice from "B"	Ice from "C"	Ice from "D"
Solution "A"				
Solution "B"				
Solution "C"				
Solution "D"				

**Sea ice photos from the Arctic**

**Iceberg photos from the Antarctic**

Photos from Bigelow Laboratory for Ocean Sciences and the Australian Antarctic Division

## AQUARIUS

Education & Public Outreach

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### EDUCATION: Classroom Activities

#### SEA WATER FREEZE

Grade Level: Middle | Time: 3 class periods | Content: Physical Science

##### Principles & Student Learning Objectives

- Substances have characteristic properties (e.g., density) that are independent of sample amount
- Observe how salinity affects the time it takes water to freeze
- Understand that salt is left behind as salt water freezes, this process forms brine
- Through experimentation, learn that ice is essentially salt-free whether formed from fresh or salt water
- Learn about sea ice vs. icebergs; see that they float higher in salt water than in fresh water

**BACKGROUND:** Sea ice is frozen seawater that floats on the ocean surface. Blanketing millions of square kilometers near the North and South Poles, sea ice can form and melt during different seasons, affecting both human activity and biological habitat. Almost all Antarctic sea ice (near the South Pole) melts away and re-forms each year. On the other hand, in the Arctic (near the North Pole) some sea ice persists year after year. Icebergs are also important in polar regions. Unlike sea ice that is formed from salty seawater, icebergs are composed of ice originating from land-based glaciers that flow into the sea. Glaciers are formed by snow that accumulates on mountains over many years. Ask the students whether snow is made of saltwater or freshwater. How do they know this? (Taste.)

**Materials:** Per Student Group – one cup of ordinary table salt, tablespoon, plastic ice tray with divided watertight sections, tap water, thermometer, 8 jars (at least 8 oz.), beakers (at least 300 ml) or cut 2L plastic soda bottles, ruler, graph paper.

**Preparation:** Students will need access to a freezer. An earth globe will also be shown to the students.

**Activity**

Begin with a class discussion of the locations of the North Pole (Arctic) and South Pole (Antarctic). Ask the students which Pole is covered by land (Antarctic) and which is covered by seawater (Arctic). Ask students which Pole is more likely to have glaciers nearby (North Pole). Ask the class to hypothesize about the affect of water salinity – or amount of salt – on the formation and buoyancy of sea ice. Do they think ice formed from salt water will freeze more quickly or more slowly than fresh water? Do they think that sea ice (i.e., formed from salty water) will be more buoyant or less buoyant than ice formed from fresh water (e.g., icebergs)? Do they think that the size of sea ice or icebergs affects their buoyancy (e.g., percentage above and below the water line)?

Label 8 jars as follows: 2 marked "A"; 2 marked "B"; two marked "C"; and two marked "D." In each jar mix salt and water solutions as follows:

- In each jar marked "A": mix 9 T salt with 1 cup water
- In each jar marked "B": mix 6 T salt with 1 cup water

**EDUCATION**

**SALINITY BASICS**

**CLASSROOM ACTIVITIES**  
Salinity Patterns & the Water Cycle

**SALINITY DATA & TOOLS**

**LINKS**

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## *The ocean is a major influence on weather and climate*

A web-based data interaction is "Salinity Data & Tools."

Users compare monthly sea surface salinity maps from the North Atlantic Ocean with:

*Air temperature*

*Sea surface temperature*

*Evaporation (E)*

*Precipitation (P)*

*E-P*

Their challenge is to find the data type that most closely corresponds to sea surface salinity patterns.

The screenshot shows the AQUARIUS Education & Public Outreach website. The main navigation bar includes: HOME, OVERVIEW, SCIENCE, TECHNOLOGY & OPERATIONS, GALLERY, EDUCATION, NEWSROOM, LINKS, and SITE MAP. The current page is titled "EDUCATION: Salinity Data & Tools".

The main content area contains the following text:

Analyzing monthly environmental data from the North Atlantic Ocean will help you to learn more about how the water cycle affects sea surface *salinity*. Your challenge is to find the data set that most closely corresponds to sea surface salinity patterns. A "Data Analysis Sheet" will help keep track of your findings and respond to the "Key Question" for each data set. Data to view include *air temperature at the ocean surface (AT)*, *sea surface temperature (ST)*, *evaporation (EV)*, and *precipitation (PT)*. Another data set of interest is the calculation of *evaporation minus precipitation (EP)*. Be sure to view all five pairs of data maps before completing your investigation. GOOD LUCK!

Navigation links: [| AT | ST | EV | PT | EP |](#)

Two maps are displayed side-by-side:

- EVAPORATION MINUS PRECIPITATION (EP)**: A contour map of the North Atlantic showing evaporation minus precipitation. The color scale ranges from -1.5 (dark blue) to 1.0 (dark red) millimeters per 3 hours. A prominent dark line (0) separates a yellow-green area (positive E-P) from a red-orange area (negative E-P).
- SEA SURFACE SALINITY (SS)**: A contour map of the North Atlantic showing sea surface salinity. The color scale ranges from 20 (dark blue) to 40 (dark red) Practical Salinity Units (PSU). The pattern of high salinity (red/orange) in the subtropical gyre and low salinity (blue/green) in the subarctic gyre closely matches the pattern of negative E-P.

A play button icon with the text "Click for monthly images" is located between the two maps.

**KEY QUESTION:**  
What is the environmental significance of the "0" line on the E-P map (i.e., dark line between the yellow and green areas)?  
*Bonus: How is E-P determined?*

Footer text: Questions or comments? Contact [Annette deCharon](#), Senior Science Educator and Aquarius EPO Manager. Monthly data maps for E-P and SS are also available in .pdf format.

Right sidebar navigation: EDUCATION, SALINITY BASICS, CLASSROOM ACTIVITIES, SALINITY DATA & TOOLS, LINKS.

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*If you have any questions, please let me know.*

*[annette.decharon@maine.edu](mailto:annette.decharon@maine.edu)*

*Thank you!*